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A Pathway to Identifying & Valuing Cultural Ecosystem Services: An Application to Marine Food Webs

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1 Introduction

The need for improved decision-making and for ecological improvements in the context of marine ecosystems has been formalized within the last decade in a number of places around the world (ACF and NELA, 2006; S.2327, 2000), including in Europe with the Marine Strategy Framework Directive (MSFD) (European Commission, 2008). The MSFD mandates not only that the state of Europe's regional seas be improved, but also that an ecosystem service[1] approach is adopted to evaluate the (economic and non-economic) impacts associated with the implementation of environmental policies.

There is one category of marine ecosystem service, however, that remains relatively neglected in the non-market valuation literature: cultural ecosystem services (CESs) (Beaumont et al., 2008; Böhnke-Henrichs et al., 2013; Rodriquez et al., 2006; Schaich et al., 2010). Cultural ecosystem services are those ecosystem services that contribute to human well-being because of the existence of a particular interpretive 'lens' (or perspective) that has its roots in one's cultural background. This distinguishes them from other ESs, the provision of which that can always be objectively measured without reference to cultural interpretive lenses. CESs generally include 'Recreation,' 'Spiritual Experience,' 'Inspiration for Culture, Art, & Design,' 'Information for Cognitive Development,' 'Aesthetic Information,' and 'Cultural Heritage & Identity' (MEA, 2005, Böhnke-Henrichs et al., 2013). Of these, only recreation as the most tangible CES has been frequently economically valued in a marine context. However, cultural dimensions of the environment relevant to each of the other, less tangible CESs can be important drivers of individual preferences for environmental change. Furthermore, there is strong evidence that elements of culture can play a significant role in driving human behaviour (both generically and in response to environmental regulation), and individual economic preferences (Bame-Aldred et al., 2013; Hoehn and Thapa, 2009; Stamieszkin et al., 2009). The connection between the environment, elements of culture, and individual preferences means that important questions are how researchers might be able to approach the challenge of economically

[1] In the context of this study, we utilise the following definition of ecosystem service: "ecosystem services are the direct and indirect contributions of ecosystems to human well-being" (Böhnke-Henrichs et al., 2013). Readers should note that 'direct' and 'indirect' in this definition relate to whether services are realised without or with other forms of capital, respectively, and do not relate to 'final' and 'intermediate' services.

valuing changes in CESs and what the methodological limitations to economically valuing changes in CESs are. This is especially relevant in contexts where there is a strong signal being sent by policy instruments (like the European MSFD) regarding the increasing importance of economic assessments of environmental changes, as framed through an ES lens.

Although there is certainly controversy surrounding the notion of economically valuing CESs[2], it is not the intention of this paper to engage directly with the larger normative question of whether or not, or under what circumstances, CESs should be economically valued. This much larger debate is beyond the scope of this paper. This paper focuses on exploring how CESs could be targeted using an economic approach to valuation, contingent upon one adopting the position that there may be some role for economic approaches to play in the assessment of CESs other than recreation. This paper therefore contributes to the literature that explores the question of how changes in the environment that are linked to CESs could, in practice, be economically valued.

Specifically, this paper develops and tests a pathway to the identification and economic valuation of CESs. The approach taken recognises that culture can be a partial generator of ecosystem services and a driver of economic value. In so doing, this pathway enables researchers to make more explicit, and to economically value, some of the cultural dimensions of environmental change that have been largely unaddressed in the marine non-market economic valuation literature published to date[3].

The objectives of this paper are as follows: i) to highlight a number of key themes in the existing CES valuation literature (section 2); ii) to present, in response to these themes, a new pathway to the valuation of CESs that augments the "standard" (economic) ecosystem service valuation framework (section 3); iii) to present the outcomes of a case study application focused on Turkey and the Black Sea that followed this pathway (sections 4-5); and iv) to critically discuss this approach to CES valuation in light of the case study experience (section 6).

2 Themes in Cultural Ecosystem Service Non-Market Economic Valuation

[2] Indeed, there are certainly some researchers who would, at one end of this debate, argue that economic approaches should *never* be applied to CESs.

[3] Unless stated otherwise, hereafter the word 'valuation' refers to 'non-market economic valuation', rather than the concept of valuation more broadly, or even the concept of value (which is broader still).

As a part of the EU FP7-funded project ODEMM[4], and in preparation for the design and delivery of this study, an extensive review of the existing primary marine non-market economic valuation literature was conducted (Baulcomb and Böhnke-Henrichs, 2014)[5]. This review identified more than 200 primary economic valuation studies published between 1975 and 2011 that were potentially transferable into an EU context[6], and classified the studies according to the service valued (as defined by the typology outlined in Böhnke-Henrichs et al., 2013)[7], the type of economic value estimated, and the non-market valuation methodology used. This review was augmented in December 2012 with a further search designed to yield peer-reviewed studies on cultural ecosystem services. Specifically, searches were conducted in ISI Web of Science using the terms Cultur* AND "stated preference" NOT cell*[8], and Cultur* AND "ecosystem service" NOT cell*. Together, these two searches yielded more than 300 results, 77 of which were considered as being potentially relevant to the topic of the economic valuation of cultural ecosystem services (in either marine or terrestrial environments) and were subsequently evaluated for information on the economic valuation of CESs. This review process has highlighted a number of important themes, two of which warrant discussion here and in the context of CES valuation using non-market economic valuation techniques.

2.1 Theme 1: A Single CES Focus

Most of the valuation studies that relate to CESs either attempt to focus on a single CES (e.g. Bell et al., 2008; Gao and Hailu, 2011; Hu et al., 2009; Hunt et al., 2007), or on a highly unspecified bundle of value that are presumed to have some cultural undertones (e.g. Landry and Hindsley, 2011; Luisetti et al., 2011; Spurgeon et al., 2004). A focus on a single CES could, in at least some instances,

[4] ODEMM stands for 'Options for Delivering Ecosystem-Based Marine Management'. Further information is available at: http://www.liv.ac.uk/odemm/

[5] Complete details of the review can be found in the cited working paper. Additionally, the studies reviewed have been uploaded onto the Marine Ecosystem Service Partnership portal: http://www.marineecosystemservices.org/explore.

[6] Here, we consider 'EU context' to include non-EU countries such as Norway, Turkey, Ukraine, and Israel that have close ties to the EU and that are relevant to the management of Europe's regional seas.

[7] There is a significant amount of debate within the ES literature on typologies. It is beyond the scope of this paper to engage with this debate, but key elements of this debate are discussed within Böhnke-Henrichs et al. (2013).

[8] It was necessary to use 'Not cell*' in the search terms to ensure that studies related to microbiology and (quite literally) culturing cells were excluded from the results

have its origin in the reluctance of some researchers to apply a reductionist and trade-off focused framework/concept to research questions related to the environment, conservation, and culture (see Baron and Spranca, 1997; Chan et al., 2012; Daniel et al., 2012a; Daniel et al., 2012b; Kirchhoff, 2012). A single CES focus may also, at least in some instances, have its origin in the fact that existing ecosystem service typologies typically lack the capacity to draw sufficiently clear boundaries between i) individual ESs within each of the broad ES categories (i.e. provisioning, regulating, habitat, and cultural), ii) the provision of any of the individual ES and the provision of the benefits that arise from those ecosystem services, and iii) different economic values types (i.e. current use values, future use values, non-use values) (Boyd and Banzhaf, 2007; Chan et al., 2012; Chapman, 2008; Fisher et al., 2008; Fisher et al., 2009; Fu et al., 2010; Wallace, 2007). Whatever its origins, however, this pattern in the literature is problematic given the lack of coverage for CESs other than recreation (Baulcomb and Böhnke-Henrichs, 2014). It means that little is known about the inter-linkages between CESs (i.e. about how the provision of an individual CES affects the provision of other CESs), and it makes it difficult, if not impossible to assess preferences for trade-offs between CESs.

2.2 Theme 2: Environmental State & Culture - The Missing Link

The second major theme apparent in the non-market valuation literature[9] is the widespread absence of explicit analysis of the link between environmental state and different aspects of culture. Instead, there appear to be three broad categories of study. The first category of studies have asked respondents to qualitatively identify how their well-being relates to the environment, but do not actually attempt to economically value these links (e.g. Martin-Lopez et al., 2012; Patterson, 2008; Pereira et al., 2005). A second category of studies assign some de facto cultural significance to particular environmental changes that are valued, but without validating the assumed culture-environment link with respondents (e.g. Bell et al., 2008; Birol and Das, 2010; Eggert and Olsson, 2009; McVittie and Moran, 2010; Milon and Scrogin, 2006; Othman et al., 2004; Ressurreicao et al.,

[9] Note that studies that approached the topic of CES valuation using non-monetary indicators (e.g. Kenter et al. (2013)) were not included in this review given the review's focus on the economic valuation of CESs.

2012). Third, other studies both enquire about culture–environment link, and feature an economic valuation, but do not fully link the two (e.g. Kenter et al., 2011).

Across the literature consulted, therefore, we could not find any studies that pursued the culture-environment link deeply enough to produce tangible CES valuations for any CES besides recreation (and very rarely 'aesthetic information' or 'cultural heritage and identity'). The pathway to CES valuation proposed and trailed in this paper seeks to address this gap by recognising the culture-environment link much more precisely. This approach is transferrable across contexts, and hence can help to support the further development of the economic valuation of CESs.

3 Pathway to CES Valuation – Augmenting the "Standard" Ecosystem Service Valuation Framework

In the "standard" ecosystem service valuation framework[10], an analytical framework in the form of an ecosystem service typology is used to categorise the effects of changes in ecological processes and functions into changes in ecosystem service supply, and valuation studies require what is tantamount to an ecological scenario, storyline, or 'narrative' that describes any relevant environmental changes (Figure 1). For example, consider the implementation of a management plan to protect and rehabilitate coastal beach dunes. In order to conduct economic valuation, researchers need to have knowledge of the magnitude of environmental change that is anticipated from the management plan. In order to characterise the changes as ecosystem services, a typology is needed that assists in characterising the ways in which people might be affected by those change (e.g., the aesthetic nature of the beach may change, and this may either be a positive or negative change from the perspective of beach users).

[Figure 1 about here]

[10] By "standard" economic approach to ES valuation, we mean the approach commonly employed when trying to arrive at economic valuations of changes in ES provision (and by extension the benefits they provide). This framework pairs an ecosystem service typology of some description, a scenario for environmental change, and seeks to both classify the later according to the elements of the former and to then estimate monetary values for those changes classified as ecosystem services.

As section 2 and the near total absence of non-recreation CES economic valuation studies highlights, however, while this approach of pairing a typology with a scenario of environmental change has enabled the economic valuation of a range of ESs, it has proven to be insufficient to organically facilitate the economic valuation of CESs. We argue that this is because this framework does not explicitly account for culture as one of the inputs to ecosystem services as it does for biophysical processes, and functions. The reason for this is that CESs require the confluence of ecosystems (or ecosystem components) and specific cultural 'lenses'. This distinguishes CESs from other ESs, the provision of which can be objectively measured without reference to interpretive cultural lenses. The defining feature of the pathway to CES valuation proposed in this paper is that it addresses this omission specifically by i) requiring the explicit documentation of the various elements of culture that are connected broadly to the environment (in what is referred to here as a "cultural brief,"[11]), and ii) formally integrating the contents of the "brief" into the ecosystem service economic valuation framework depicted in Figure 1.

Integrating the contents of the cultural brief into the valuation framework shown in Figure 1b requires identifying the sub-set of culture-environment linkages that are both connected to the specific environmental changes identified in the ecological narrative (i.e. descriptions/scenarios of plausible ecological change) and classifiable as ecosystem services under the selected ecosystem service typology. The full integration of the cultural brief with the standard valuation framework yields our augmented ES valuation framework (Figure 2). In the context of the hypothetical dune rehabilitation scenario introduced above, this would mean documenting, broadly, what elements of the culture of the target population were connected to beaches, for example, and specifically seeking to interpret those culture-beach linkages through an ES lens as defined by the typology selected for use in the research. Augmenting the standard ecosystem service valuation framework in this way creates a new pathway to the valuation of CESs, because it specifically recognizes the necessity of pairing cultural insights with ecological changes in order to arrive at a sub-set of environmental changes that affect the

[11] This documentation could take many forms, including for example, a list of the main themes that arose through semi-structured interviews, a synthesis of secondary literature on locally or regionally existing culture-environment connection, the outputs of a questionnaire designed to elicit these linkages, etc.

provision of CESs. This is especially relevant if there is a need to formally consider the specific, rather than generic, cultural ramifications in impact assessments of proposed policies.

[Figure 2 about here]

Actually implementing valuations that utilise this augmented framework requires that the valuation process includes the following four specific components: 1) the simultaneous development of the ecological narrative (i.e. the scenario of environmental change) and the cultural brief (i.e. the documentation of culture-environment linkages) ; 2) the selection of a well-defined ecosystem service typology; 3) the development of a set of detailed, multi-dimensional depictions either of CESs directly or of the environmental components that connect strongly to the identified CESs for use within the valuation study questionnaire; 4) a means within the valuation questionnaire of confirming the anticipated CES interpretations. The multi-dimensional depictions referred to as component 3 are important for improving the realism of the valuation scenario. The four components are detailed further below and should be applicable in both place-based studies and non-place-based studies (such as the case study presented in section 4). In the context of the hypothetical beach dune rehabilitation example given above, if there was evidence that the culture-environment linkages connected to more than just the literal sand dunes themselves, this would mean that the valuation scenario should consider not just changes to the dunes themselves (in a very literal way), but also some of the changes in biodiversity related to the rehabilitation of the dunes.

3.1 Component 1: Simultaneous Development of the Ecological & Cultural Case Study Inputs

The simultaneous development of the ecological narrative and the cultural brief is important, because it ensures that there is sufficient continuity between the ecological and cultural inputs to integrate them as described above. The ecological narrative can be based on anything from categorical descriptions of ecological changes to the outcomes of spatially and temporally explicit dynamic ecological simulations. The cultural brief can be developed using a variety of approaches, including

respondent interviews, focus groups, consultations with local cultural experts and historians, and analysis of existing culturally-focused studies. The information collected through this process feeds into the identification of the specific ecological features that are most strongly connected to culture within a particular case study, and should be utilised in the design of the valuation questionnaire.

3.2 Component 2: Mapping the Ecological & Cultural Inputs onto a Well-Defined Ecosystem Service Typology

An appropriate analytical framework in the form of a well-defined ecosystem service typology is required to identify the CES relevant to a particular case study once the ecological narrative and cultural brief exist. For the purposes of this approach, a 'well-defined' typology has a sufficiently specific internal infrastructure that allows drawing clear and consistent distinctions between each of the named ecosystem services (Böhnke-Henrichs et al., 2013). An ecosystem service typology that exhibits these characteristics is a necessary precondition to being able to use that typology to classify particular cultural-ecological linkages as specific CESs. Mapping both the ecological narrative and the cultural brief onto each other and onto an ecosystem service typology (as conceptualized in Figures 1, 2) may be somewhat of an iterative process. In the context of beach dune rehabilitation, for example, it could be that some of the ecological changes wrought by rehabilitation are better classified as changes to ecosystem functions or processes, rather than services. Similarly, there may be elements of culture identified that link to certain parts of the coastal environment that are not actually sufficiently connected to the parts of the ecosystem that would change with successful beach dune rehabilitation, and so would be irrelevant to this particular case study. When implementing this approach, researchers need to identify the sub-set of culture-environment linkages that are relevant to the specific scenario of ecological change and that can be classified as CESs.

3.3 Component 3: Detailed, Multi-dimensional Depictions of CES

The third component relates to the question of how to best depict the cultural-ecological linkages that are classifiable as CESs in the valuation study once they have been identified. In the context of choice experiments, this refers to the representation of individual attributes. In the context of contingent valuation studies, this refers to the depiction of the valuation scenarios. In either case, what is presented to respondents needs to be both ecologically and culturally meaningful, as well as readily interpretable. This may mean pictorial attributes are more useful than written descriptions of environmental change. In some instances, mapping an ecological narrative and a cultural brief onto an ecosystem service typology will yield linkages that are most easily depicted by emphasizing their ecological dimensions. In contrast, in other instances the relevant linkages will be most easily depicted by emphasizing their social dimensions.

Additionally, because these cultural-ecological linkages are inherently multi-dimensional, and because oversimplification can obscure the nature of these linkages, it is necessary to retain at least some of this multi-dimensionality within the depiction of the featured cultural-ecological linkages. This means that if, for example, changes in species population sizes are found to be culturally relevant, classifiable as an ecosystem service, and relevant to the valuation, then respondents must be provided with explicit information on specific species, rather than with a more generic statement about the number of (unnamed) species experiencing improvement. Providing respondents with a fairly detailed picture within the valuation study is supported by research demonstrating that it is preferable to provide more complete information in stated preference studies than it is to provide greatly simplified information simply to avoid survey design complexity (Hensher, 2006).

3.4 Component 4: A Means of Confirming Cultural-Ecological Linkages

If the respondents bring to the study a cultural frame of reference that is fundamentally different to that developed when researching environment-cultural linkages at the stage of creating the cultural brief, interpreting the resulting willingness-to-pay (WTP) estimates will prove to be problematic (i.e. a change that could be primarily interpreted by one set of respondents as being aesthetic in nature may to another set of respondents be primarily relevant to recreation). Therefore, valuation studies must

contain some means of verifying that the key aspects of the cultural brief on which the study is founded apply to the respondents sampled. To this end, attitudinal questions and open-ended questions that are specifically designed to 'ground-truth' CES interpretations (rather than simply capture facets of respondent heterogeneity) should be included.

4 Demonstrating the Pathway to Cultural Ecosystem Services Valuation: A Marine Food Webs Case Study in Turkey

The approach presented in section 3 was followed in a choice experiment valuation case study in the district of İstanbul, Turkey. This case study focused on the culturally-relevant ecological consequences of striving to achieve good environmental status (GES) with respect to the Black Sea food webs between 2012 and 2020. A food web is the full system of food chains found within an ecosystem. Food chains represent the pathways through which energy and matter move within an ecosystem and are defined by predator-prey relationships at different trophic levels. The focus of this particular case study stemmed from an ecological pressure assessment conducted for the Black Sea as a whole that showed new marine management measures would be needed to ensure compliance with the MSFD with respect to the health of food webs within the Black Sea (Breen et al., 2012; Knights et al., 2011; Robinson and et al, In prep). Because marine food webs as the subject of this case study are highly mobile, and do not readily constitute features of a landscape, they are not particularly amenable to place-based assessments of cultural relevance. The phases of the case study are described below.

4.1 Initial Methodological Steps: Formulating the Ecological Narrative and Cultural Brief

The ecological scenario (or narrative) underpinning this study was developed in conjunction with a team of marine scientists (including Black Sea specialists) from the project ODEMM, and started with the identification of representative (i.e. 'flagship') species within the Black Sea food web (Supplementary Information (SI), Table 1). These species were taken to be representative of the plankton, molluscs, jellyfish/ctenophores, seabirds, oily fish, pelagic fish, demersal fish, seabirds, and

marine mammals in the Black Sea. The scenarios considered the past history of eutrophication, over fishing, the blooms of the ctenophore Mnemiopsis leidyi, the impact of this history on the identified flagship species to assess the impact of new management measures targeting eutrophication and over fishing on these species, and by extension, on the health of the Black Sea food web. Plausible changes to those species under possible new management regimes were considered with respect to either a moderate or a substantial increase in the intensity and scope of management interventions focused on maintaining the health of the Black Sea. These changes were assessed by according to the expert judgment of the scientists involved. This provided an idea of what magnitude of change could reasonably be expected from increased marine management in the Black Sea.

The development of the cultural brief, in contrast, involved trying to identify points of culture-environment linkages between Turkey and the Black Sea, both generically and specifically with regards to elements of the Black Sea food web (and hence the identified flagship species). The connections between food webs and elements of Turkish culture within the İstanbul District were identified in several stages. Firstly, an open-ended workshop was held within the project team. The purpose of this workshop was to collect the existing knowledge and experiences of the project team regarding potential points of connection between elements of Turkish culture and various components of the Black Sea, including those components connected to the health of the Black Sea food web, as well as to brainstorm hypotheses about a culture-environment linkages in the context of the Black Sea. The outputs of this workshop were 1) a skeleton outline of possible elements of culture-environment linkages to be further investigated, 2) rough sketches of a wide range of possible attributes (for the choice experiment survey), 3) the design of a cultural scoping interview questionnaire (to facilitate the team both eliciting and checking culture-environment linkages in semi-structured interviews with respondents), and 4) first drafts of the key attitudinal questions intended to fulfil the validation requirements described in section 3.4. Together, the collected knowledge and hypotheses formed the first draft of the cultural "brief".

Secondly, the contents of the cultural brief were expanded upon and verified using the outcomes of 18 semi-structured interviews with residents in İstanbul and Şile. These interviews explored the themes, ideas, and hypotheses highlighted in the project-team workshop (SI Table 2), as

well as any additional themes spontaneously raised by interviewees themselves. Combined with both the narrative of ecological change in the context of Black Sea food webs, and a comprehensive marine ES typology (Böhnke-Henrichs et al., 2013), these interviews provided the evidence necessary to construct four attributes for the choice experiment with plausible cultural-ecological linkages that were also classifiable as marine CESs. The themes identified in this process guided the selection of attributes is described in section 4.2.

4.2 Intermediate Results: Key Themes and Attributes

Three key themes emerged from this process: 1) the maintenance of the overall "natural environment" of the Black Sea, as an entity, and as expressed through the availability of species and the ability to participate uninhibited in activities involving the Black sea, is important to (local) individuals' sense of being Turkish[12]. In other words, the respondents from the semi-structured interviews felt that their sense of being Turkish was sensitive to their perception of the overall health of the Black Sea; 2) meals featuring traditional anchovy recipes were seen to be important, because their consumption was seen to be an important means of actively participating in (local) 'Turkish culture'; and 3) maintaining the tradition of preparing and partaking in these traditional meals is an important mechanism of transferring (local) 'Turkish culture' between successive generations. The focus on anchovies was accompanied with a concern about specific dimensions of anchovy quality and future anchovy availability. Interestingly, respondents gave little emphasis to the sustenance (or provisioning i.e. sea food) dimension of these traditional meals, emphasizing instead the cultural dimensions of the fish. Thus, although superficially it might seem like anchovy quality and availability would be relevant only to the 'Sea Food' provisioning service, in this case, it can be more appropriately considered in the context of CESs.

Building on these themes, the final attributes developed for use in the choice experiment were as follows: 1) the visibility of flagship species in Turkish coastal waters and cities; 2) the population size of flagship species in the Black Sea; 3) the intensity, timing, and duration of ctenophore &

[12] There are, of course, many different varieties of Turkish identity. We do not mean to imply statements about all of these, and instead reflect what the respondents we interacted with expressed to us as being relevant to their sense of what it meant to be Turkish.

jellyfish blooms; and 4) the seasonal availability, quality, and source of anchovies (Engraulis encrasicolus) for use in traditional meals. The levels for these attributes were set by Turkish marine scientists to reflect the magnitude of ecological change that could plausibly follow over an 8-year time period from the implementation of either a moderately intensive or substantially intensive marine management regime. These attributes and the links to CESs derived from the semi-structured interviews are described individually in sections 4.2.1-4.2.4. Depictions of each of the final levels for each of the attributes featured in the choice experiment can be found in the supplementary information (see SI Figure 1 and also SI Table 3).

4.2.1 Species Visibility & Western Shelf Populations

The species visibility attribute represents how often the flagship species are visible, locally, within Turkish waters. In contrast, the species population attribute refers to the population size of each of the flagship species at the scale of the Western Shelf of the Black Sea. Both aspects were found to be relevant in the semi-structured interviews, and therefore included as attributes. The depiction of both attributes ultimately uses an ordinal scale (SI Figure 1). Ecologically, both attributes were included, because the local presence of these species cannot necessarily be inferred from larger scale population changes, especially over the course of the study's 8-year time horizon (i.e. 2012-2020). Culturally, however, the scoping work indicated that these two attributes relate to slightly different CESs. The semi-structured interviews provided evidence that non-commercial fishing (the continued existence of which is underpinned by the health of the Black Sea) is perceived, at least within the İstanbul district, as an important component of Turkish cultural heritage. Therefore, it was hypothesized that values associated with the population attribute - as the attribute that reflects the regional ecosystem underpinning the extractive activities - would capture a portion of the consumptive use value associated with cultural heritage and identity (CHI). The semi-structured interview phase of the study also provided evidence that the existence of a balanced and healthy Black Sea underpinned the local residents' perceptions of Turkish heritage. It was hypothesized, therefore,

that the visibility attribute – the attribute intended to reflect the local 'presence' of the Black Sea food web – would capture a portion of the non-consumptive use value associated with CHI.

Both these attributes were represented pictorially. A pictorial representation of the flagship species aligned well with the focus on the food web in the Black Sea as it explicitly depicted relative changes in the representative species within this food web. This afforded respondents the opportunity to assess the range of multi-species consequences implied by the increasingly intensive management within the Black Sea ecosystem (Table 1, SI Table 3). Initially, spider diagrams were used. However, participants during the pre-test of the choice experiment unanimously voted to alter the presentation to a bar chart (Figure 3) to improve the interpretability of the choice cards in the final questionnaire.

[Figure 3 about here]

4.2.2 Ctenophore & Jellyfish Blooms

Ecologically, the ctenophore and jellyfish (hereafter referred to collectively as the 'jellyfish') bloom attribute was included, because excessive blooms of species like Mnemiopsis leidyi, Beroe ovata, Rhizostoma pulmo, and Aurelia aurita have contributed to shifts the Black Sea food web since the 1980s (Daskalov et al., 2007; Kideys, 2002; Vinogradov et al., 1989). Culturally, background research indicated that jellyfish blooms most likely impacted two CESs: 'Recreation' and 'Aesthetic Information.' Consequently, it was hypothesized that: i) the culturally-relevant impacts of blooms are distinct from those associated with the population and visibility attributes; and ii) the culturally-relevant impacts of blooms could be categorized as a combination of the non-consumptive use values associated with 'Recreation' and 'Aesthetic Information.'

The depiction of this attribute shows the intensity, timing, and duration of 'bloom seasons' (Figure 4). This is a different approach than has often been adopted in the past by non-market valuation studies that feature algal or jellyfish blooms. Existing studies have tended to either include several dimensions of the event in question , but as separate attributes and hence at the cost of excluding other ecosystem services from the choice experiment (e.g. Taylor and Longo, 2010), or

have tended to include multiple ecological features/ecosystem services within the non-market valuation exercise, but have then only considered a single dimension of the blooms (e.g. Kosenius, 2004, 2010). By having a single bloom attribute that is, itself, multi-dimensional, our choice experiment is able to consider more than blooms while at the same time providing respondents with a more complete picture of the changes implied by the scenarios shown on the choice cards.

[Figure 4 about here]

4.2.3 Anchovy Availability & Traditional Meals

This attribute related to the quantity, availability, source, and quality of anchovies available for use in traditional meals in Turkey. Ecologically, the state of anchovies within the Black Sea is important, because they feed at fairly low trophic levels, and are, therefore, key to the passage of energy through the Black Sea food web (Prodanov et al., 1997). Culturally, the dimensions of this attribute were directly informed by the semi-structured interviews that were conducted in İstanbul. Given the clear cultural significance of anchovy-based traditional meals, it was hypothesized that the values associated with this attribute would relate to the cultural value of the meals themselves, rather than to the cultural relevance of the act of fishing in the Black Sea, or to the provisioning service 'Sea food'. We anticipated, therefore, that values associated with this attribute would capture an element of use value associated with CHI that is not captured by either the population or visibility attributes.

4.2.4 Payment Vehicle & Price Attribute

The payment vehicle used in this study was an increase in the household annual water bill, every year for 8 years (i.e. between 2012 and 2020). This payment vehicle was chosen because it was well understood by respondents and was found to not provoke any extreme reactions from respondents. The price attribute that accompanied these attributes had six levels (in 2012 Turkish Lira: 3, 7, 20, 60, 150, 400). These levels were determined based on responses to an open-ended

question within the pre-test that elicited maximum annual WTP, for eight years, for the scenario with the most significant environmental change. The highest level was chosen to align approximately with the 95th percentile of WTP responses.

4.3 Non-market valuation methodology & data collection

The questionnaire used in this study was pre-tested in a workshop with 15 respondents in İstanbul in June 2012. The final questionnaire was then administered in June and July 2012 to 291 respondents across İstanbul and Şile through a series of 14 workshops[13]. The sample of respondents was obtained through on-street recruitment of adults aged 18+ in three parts of the city. The workshops were divided into five parts, and included a presentation on Black Sea food webs and CEs, and an associated question and answer session that preceded the delivery of the survey itself. In this respect, the workshops were both semi-deliberative and participatory.

The survey included a variety of question types including open-ended, Likert-type, and multiple-choice attitudinal questions. These questions preceded the CE and featured the following themes: the need for immediate action, responsibility, a willingness to make trade-offs in exchange for improvements to the biology of the Black Sea, and links between different elements of 'Turkish culture' and the health of the Black Sea food web. The experimental design for the CE was a D-efficient, fractional factorial main effects design generated using Ngene (ChoiceMetrics, 2012). It consisted of 18 choice sets, split into 2 blocks that were randomly allocated to the respondents. Each respondent therefore faced 9 choice sets. A typical choice card is shown in SI Figure 2. The order of choice sets within each individual survey packet was also randomized in order to minimise potential sequencing effects (Day and Pinto Prades, 2010). The questionnaires were provided in the workshops in a full-colour paper format, in Turkish, and respondents filled it out themselves following the participatory portion of the workshops.

[13] Note: This study did not aim to be representative of the population of either Turkey or the province of İstanbul, but serves instead to illustrate the proposed pathway to the non-market valuation marine CESs. Nevertheless, a comparison of the characteristics of our sample to the population of Turkey and the İstanbul province, specifically, revealed that our sample was by and large younger and more educated than would otherwise be expected (Turk Stat, 2000). This is not surprising given the illustrative nature of this case study and the interception-based sampling.

The data collected through this experiment were analysed using a mixed logit (MXL) model. The MXL model (Train, 2003) is now commonly applied to relax restrictive assumptions about the distributions of the error term and the related behavioural assumption of independence of irrelevant alternatives (IIA) that present in the standard multinomial logit model. In the MXL model, parameters are assumed to be randomly distributed, thus capturing unobserved heterogeneity in sensitivities to attributes, meaning that the mean and variance of the random parameter distributions are estimated, taking repeated choices made by the same individual into account (panel data setting). In the MXL applied to the study data, the cost attribute was considered to be fixed, and based on model fit statistics, we decided to report model estimates of the model that assumes all non-price attribute parameters follow a normal distribution. Further, correlation across the two policy alternatives is introduced through the use of an additional 'error component' that accounts for the correlation of the utilities across these alternatives (Hess, 2005).

Because our sample was, on average, more educated than the population within the sampled Turkish district, it was necessary to test whether or not having a university education had a significant impact on mean respondent sensitivity to changes in the non-price attributes parameter values. Consequently, a number MXL models featuring interactions between the non-price attributes and a higher education dummy variable were estimated. Estimates of (unconditional) mean willingness to pay (WTP) values were derived for the MXL model with interactions based on unconditional (i.e. population) distributions, and 95% confidence intervals were calculated using the Krinsky-Robb method (Krinsky and Robb, 1986).

The 'higher education' dummy variable was also interacted with price. In this case, however, the interacted term served as a proxy to enable us to explore how respondent sensitivity to price relates to income. Higher education as a proxy for income is justifiable, because there is a well-documented correlation between income and education specifically in Turkey (Sari and Soytas, 2006; Tolley and Olson, 1971). It was necessary to use this proxy because the survey data on income suffered from a greater incidence of missing observations than did the education data.

5 Case Study Results

5.1 Econometric Results

No participants refused to participate in, or complete the study, and only 9% of respondents selected the status quo option for every choice card. This means that no more than 9% of the 291 respondents sampled can be considered to be 'protest' responses. In the basic MXL model, all of the attribute parameters are significant at the 1% level with the expected sign, indicating increased utility from improvements to the Black Sea food web (Table 1). As expected, the price parameter is negative and significant, reflecting the disutility, ceteris paribus, associated with payments for environmental improvement. Furthermore, several of the standard deviations of random parameters are significantly different from zero, indicating that unobserved heterogeneity in preferences for the CES attributes should not be ignored. The generally negative and significant parameter values of the alternative specific constant (ASC) associated with the BAU option show that respondents had a propensity to choose the policy options instead of the BAU that cannot be explained by attribute information. The variance of the additional error component (σ) is highly significant. Its value suggests that respondents, for other reasons not explained by the attributes used in the study, view the two policy options as similar relative to the BAU.

[Table 1 about here]

The only education-attribute interaction term that is statistically significant is that between education and price (Table 1). This indicates, as expected, that respondents with a higher level of education exhibit lower marginal utility of income. The lack of statistically significant interaction terms between education and the non-price attributes is not, in and of itself, sufficient to prove that the choice tasks were overly complex for respondents. Had complexity been driving respondent choices (as opposed to preferences for shared culturally-significant ecological changes), we would have expected to see highly significant interaction terms in this model. The manageability of the choice tasks is further corroborated by information from responses to follow-up questions after the completion of the choice tasks. When probed about their level of confidence in the choices made,

67% of respondents stated that they were confident, as opposed to 17% who felt unconfident to any degree. Additionally, only a rather small proportion of the sample (11%) reported that making decisions in the choice tasks was difficult to any degree. Therefore, we believe that, on the whole, respondents did not experience an information overload (Park and Jang, 2013; Scheibehenne et al., 2010), although we acknowledge that some respondents may have struggled to cope with the information load either related to the choice experiment instrument or the possibly unfamiliar valuation context.

Results of the MXL model with the interaction of price and education were used to estimate the overall mean (i.e. unconditional) values of marginal WTP (MWTP) per year for each attribute included in the choice experiment. Additionally, we report annual MWTP values based on level of education achieved (Table 2). These MWTP values represent mean values to be paid annually for 8 years.

The MWTP values show an implied ranking of the attributes associated with marine management targeting the health of the food web in the Western Shelf of the Black Sea. MWTP values are highest for improvements to the species population and the availability and quality of anchovies. Jellyfish blooms and local species visibility are considered to be somewhat less relevant in this context, but still have MWTP values of considerable magnitudes. For example, respondents were willing to pay, on average, 27 TL per year for the reduction in late summer bloom intensity from 'moderate intensity' to 'low intensity' (see attribute levels as shown in SI figure 1 associated with moderate and substantial management for this attribute). Respondents were also willing to pay 20 TL per year for the visibility of Atlantic bonito, blue fish, turbot, whiting, and grey mullet (i.e. pelagic and demersal fish species) to improve from being 'commonly visible' to 'very commonly visible' (see attribute levels as shown in SI figure 1 associated with moderate and substantial management for this attribute). Importantly, the MWTP results demonstrate that a simple internal scope test is passed, as is expected by economic theory. In other words, MWTP for the attributes associated with moderate management intervention and improvement is less than or equal to the MWTP for 'the attributes associated with substantial management intervention and improvement.

5.2 Attitudinal Validation of Hypotheses Related to the Cultural Ecosystem Service Dimensions of the Choice Experiment Attributes

Information garnered from the supporting questions can aid in the validation of the cultural and CES dimensions of the attributes used in the choice experiment. The results show that the key themes that arose within our sample in response to the attitudinal questions closely parallel the themes that emerged from the cultural scoping study. For example, there was strong agreement amongst the respondents that the health of the Black Sea was threatened by humans and requires immediate attention by a range of actors, including the region's governments, sectors (such as agriculture and fishing), and citizens. Our sample displayed a strong hypothetical willingness to trade some impairment in a number of aspects relevant to economic and cultural life (for example, the rate of economic growth, religious customs, inspiration for artists, and recreation) for improvements in the health of the Black Sea food web, if necessary. There was less evidence, however, of willingness to support other potential trade-offs in return for improvements in the health of the Black Sea food web (for example, the aesthetics of the Black Sea, cultural heritage, or opportunities to study the Black Sea). These questions also confirmed the dual impact of jellyfish blooms on recreational opportunities and the aesthetics of the Black Sea, the importance of Black Sea anchovy dishes to 'Turkish culture', the cultural importance of small-scale fishermen in the Black Sea, and the importance of the health of the Black Sea and the continued relevance of certain expressions of 'Turkish culture' (including songs, dance, poetry, and children's stories) (SI Table 4).

Overall, therefore, the responses given to these attitudinal questions confirm, by and large, the outcomes of the cultural scoping efforts. Therefore, they also support not only the hypothesized relevance of the health of the Black Sea ecosystem to 'Turkish culture' local to the İstanbul district, but also the hypothesized attribute-CES connections.

6 Discussion

This paper presents a pathway that facilitates a more explicit recognition of multiple CESs in non-market valuation studies. The case study application presented in this paper is, consequently, the

first non-market valuation study in a marine environment to formally consider culture as a generator of ecosystem services, and is also the first to design CE attributes specifically in response to respondent perceptions about the links between their culture and a particular ecosystem.

The statistical significance of the model results combined with the overall level of confidence of respondents in the choices made indicates that the depictions of the cultural-ecological linkages featured in this study were meaningful, interpretable and relevant to most respondents. Although the sampling does not allow generalisation of WTP estimates to the whole population of İstanbul or Turkey, the WTP estimates generated did demonstrate sensitivity to scope. This sensitivity to scope highlights that the approach to valuation proposed in this study is capable of producing WTP estimates that are consistent with economic theory (Smith and Osborne, 1996). This suggests that the approach demonstrated here has some potential when paired with a larger and more precisely defined sample to be of relevance to policy analysis.

The results of the study additionally demonstrate that it is possible to use targeted attitudinal questions to assist in both the final interpretation of the valuation results and in the confirmation of the anticipated cultural-ecological linkages. Overall, therefore, the outcomes of the case study support the approach described in section 3, including the augmentation of the standard ES framework, as a means of identifying cultural-ecological linkages, and valuing environmental changes that can be clearly linked to CESs. Given these elements of success, it is anticipated that pairing a more detailed scenario of ecological change with a more detailed analysis of the culture-environment linkages might in the future allow for a design of attributes that are much closer to the CESs themselves (rather than the ecological features that are of cultural significance in a particular way). This would yield a more clear-cut economic valuation of CESs and facilitate the analysis of trade-offs between them.

In addition to these promising outcomes, however, it is worth noting some of the features of the case study that highlight important areas for future methodological improvement. One challenging feature of the study was the need to include spatial scale as one of the attribute dimensions discussed in section 3. Respondents were asked to consider trade-offs between local and regional scale ecological changes when considering the population and visibility attributes. Although we have no clear evidence that this was particularly problematic within this case study, or that our study design

approached a threshold of complexity/abstractness (Greifeneder et al., 2010), we cannot deny the possibility that some respondents may have had difficulty maintaining a clear distinction of scales, and there is some anecdotal evidence from individuals that this was the case. This suggests a need for future research to explicitly test how to most effectively incorporate trade-offs between multiple spatial scales within non-market ecosystem service valuations.

Similarly, there is a need to consider the extent to which the adoption of more formally deliberative approaches to valuation (Blamey et al., 2000a; Christie et al., 2006; Christie et al., 2010; Christie and Rayment, 2012; Howarth and Wilson, 2006; Kenter et al., 2011; Macmillan et al., 2002; Spash, 2007, 2008; Szabo, 2011; Wilson and Howarth, 2002) could aid respondents in handling the fairly large amounts of information required by this approach to CES valuation. In addition to aiding in the processing of large amounts of information, deliberative valuation may help to lower the risk of sources of bias such as lexicographic preferences, yea-saying, insensitivity to scope, and "belief bias" affecting the valuation estimates (Blamey et al., 2000a; Blamey et al., 2000b; Szabo, 2011). Furthermore, deliberative valuation may allow respondents to adopt an explicit pro-equity perspective (Wilson and Howarth, 2002), may reduce the number of protest responses (Szabo, 2011), and may help to reduce the variability of valuation estimates (Christie et al., 2006). Furthermore, because CES values are connected to past, present, and future social interaction, it seems plausible that deliberative methods could lead to improved insights regarding the connections between ecological change, culture, and perceptions about CESs.

When comparing this case study to existing examples of deliberative valuation, it is clear that it did share some similarities with approaches such as the citizens' jury in that 1) individuals were able to interact with, and question, 'expert witnesses' on the Black Sea food web; 2) there was a significant emphasis on providing respondents with the sufficient information and time to fully consider the trade-offs between attributes (Blamey et al., 2000a; Howarth and Wilson, 2006); and 3) the case study assumed that the way in which respondents translated the information provided into economic preferences is not unique to the specific individuals within the sample used (Blamey et al., 2000a). The case study did not, however, afford respondents a formalized opportunity to engage directly with each other on the information presented. It is possible, therefore, that the adoption of some of the key

features of formal deliberative methods such as facilitating respondents interaction with each other, and affording respondents the opportunity to engage with the material for longer periods of time, would further strengthen CES valuation, given that they can strengthen non-market valuation of complex 'goods' in other contexts (Christie et al., 2012; Christie et al., 2006; Christie and Rayment, 2012; Kenter et al., 2011; Macmillan et al., 2002; Szabo, 2011).

However, deliberative valuation is not without its limitations (Blamey et al., 2000a; Howarth and Wilson, 2006; Wilson and Howarth, 2002). For example, its adoption in CES valuation contexts could potentially undermine the ability of researchers to generalize their results to larger populations (Blamey et al., 2000a; Howarth and Wilson, 2006; Spash, 2007). In cases where the end goal is the generalization of CES valuations across a certain population, and their inclusion in formal economic analyses alongside other economic data, this incommensurability of valuations would be problematic. The overall helpfulness of employing deliberative valuation in the context of CES therefore remains a topic for future research.

Additional improvements could result from a more strategic application of attitudinal questions than was undertaken here. The questions asked in this case study were fit for purpose in that they aided the confirmation of the hypothesized CES-attribute links. However, these questions could have been more focused on systematically teasing out the different dimensions of the attitudes and beliefs relevant to the CES-attribute links. This could have improved the results in two ways. Firstly, it could have led to a more in-depth understanding of the link between ecological change and CESs in the Black Sea, inclusive perhaps, of an improved understanding of the specific economic value types (e.g. the current use values, future use values, and/or non-use values) most associated with individual CESs. Secondly, it could have, for example, allowed for the development of reliable scales that capture relevant dimensions of CES. Such scales could then be used to explain preference heterogeneity, for example following a latent class approach (Boxall and Adamowicz, 2002; Glenk and Colombo, 2011; Nunes, 2002), or a latent variable approach (Hess and Beharry-Borg, 2012) to the analysis of the data. Recent efforts to develop a scale of non-monetary cultural indicators show some progress in this regards (Kenter et al., 2013), but these scales have yet to be used to directly aid in the interpretation and understanding of monetary valuation efforts focused on marine CESs.

A final source of improvement to the proposed pathway to CES valuation relates to the type of ecological inputs utilised. Expert judgment was used throughout the study in part owing to the paucity of such data on the connection between ecological change and ecosystem services in the Black Sea. The ecological narrative was, in this case, still fit for purpose in that it provided an over-arching 'storyline' to help anchor the study as required. A preferable alternative, however, would have been the use of ecosystem service 'response functions,' or more detailed, model- or data-driven ecological inputs (Barbier et al., 2008; Barbier and Strand, 1998; Hasselström et al., 2012). Although still not often accomplished within ecosystem service valuation studies, we expect that more closely coupling the valuation to data- and model-driven ecological inputs would increase the robustness of the resulting valuation results, and hence, their policy relevance.

As is probably inherent to any undertaking endeavouring to progress the valuation of CESs, there are numerous challenges and possibilities for improving the valuation process. Given the promising findings from the Turkish case study, however, we believe that the challenges are largely surmountable with future research, and consequently, that the proposed pathway to CES valuation should continue to be explored, implemented and refined by further applications in both marine and terrestrial contexts.

7 Conclusions

This paper reports on the development and demonstration of a pathway to the non-market valuation of CESs. At the core of the approach is the recognition that culture is a generator of ecosystem services that affect individual welfare, and that consequently, valuing CESs requires pairing both ecological and cultural insight with a well-defined and internally consistent ES typology. This pathway helps to fill a definite gap in the ecosystem services valuation literature because it enables researchers to explicitly identify, and then economically value, cultural dimensions of environmental change, an arena that remains under-researched in a marine context.

When tested in our case study, this approach showed definite promise. Attributes were designed specifically with CESs in mind, and both environmental and cultural inputs underpinned their design.

The information presented to respondents was much more specific and detailed than has often been typical of CEs related to ecosystem services, and yet was still found to be largely interpretable and meaningful to respondents. The use of targeted Likert-type questions and open-ended questions aided significantly in the interpretation of the attributes, and in the documentation of the links to marine CES.

Further developments of this pathway to CES valuation should enable more specific and explicit dimensions of CESs to be valued in an economically consistent way. Subject to further development, this approach also has the potential to support the analysis of economic preferences for trade-offs between marine CESs, a topic that has, to date, remained wholly unexplored within the marine ecosystem services literature. Ultimately, therefore, we recommend that future research build upon the work presented here in order to capitalize on the potential demonstrated by this approach, and further improve the available knowledge regarding the way that environmental change affects CESs, and the way in which culture informs environmental values.

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Figure Captions:

Fig. 1 Conceptualization of the integration of an analytical framework (in the form of an ES typology) onto a narrative of ecological change. This integration allows for the identification of particular ES that become the focus of non-market valuation studies.

Fig. 2 The full, augmented ecosystem service framework. Of all the elements of a particular culture that are sensitive to environmental change, only some of those will be sensitive to changes in any particular ecosystem; Of all the elements of a particular culture that are sensitive to environmental change, only some are classifiable, using an ES typology, as CES. Identifying individual CES that are not only relevant to the particular ecosystem and ecological change that are the intended focus of a case study, but also classifiable as CES using an ES typology requires an ecological narrative, a cultural brief, and an ecosystem service typology.

Fig. 3 Example of the business-as-usual (BAU) depiction of the species population attribute in the final questionnaire. The visibility attribute shared the same bar chart design, though the ordinal scale differed from that of the population attribute

Fig. 4 One of the levels of the jellyfish and ctenophore bloom: (White=No Bloom; Grey=Low Intensity; Teal=Moderate Intensity; Black=High Intensity)

Supplementary Information

Baulcomb *et al.* Submitted. A Pathway to Identifying & Valuing Cultural Ecosystem Services: An Application to Marine Food Webs. *Ecosystem Services* xx(xx):xx-xx

SI Table 1

Black Sea flagship species considered in this study

Category	Name	Species	Category	Names	Species
Dolphins	Bottlenose Dolphin	*Tursiops truncatus ponticus*	Rare, Large Fish	Sturgeon	*Acipenser colchicus*
	Common Dolphin	*Delphinus delphis*		Cormorant	*Phalacrocorax carbo*
Rarer Marine Mammals	Harbour Porpoise	*Phocaena phocaena*	Sea Birds	Common Gull	*Larus canus*
Pelagic Fish	Atlantic Bonito	*Sarda sarda*		Black Headed Gull	*Chroicocephalus ridibundus*
	Blue Fish	*Pomatomus saltatrix*	Shell Fish	Mediterranean Mussel	*Mytilus galloprovincialis*
Oily Fish	Horse Mackerel	*Trachurus trachurus*		Veined Rapa Whelk	*Psetta maxima*
	Anchovy	*Engraulis encrasicolus ponticus*	Gelatinous Creatures	Comb Jelly	*Mnemiopsis leidyi*
	Turbot	*Rapana Venosa*		Moon Jelly	*Aurelia aurita*
Demersal Fish	Whiting	*Merlangius merlangus*	Assorted Plankton	-	-
	Grey Mullet	*Mugil cephalus*			

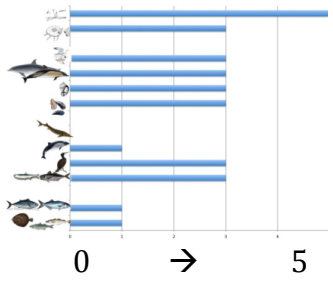
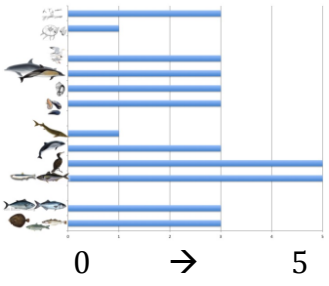
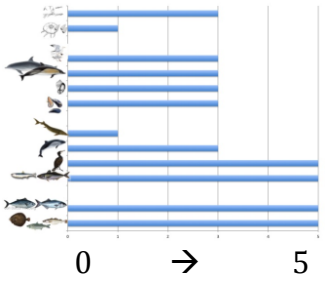
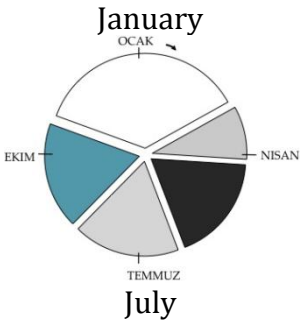
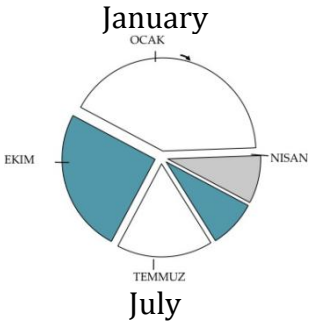
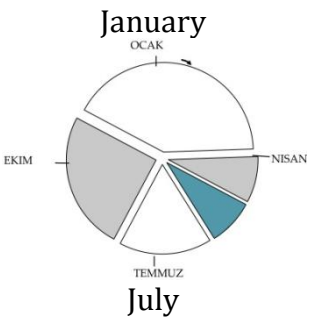
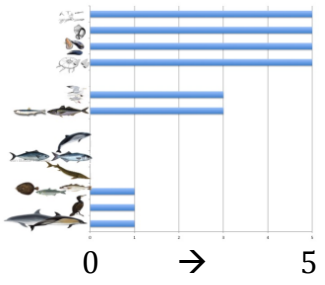
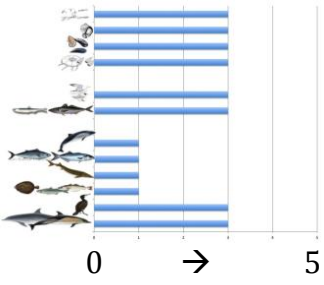
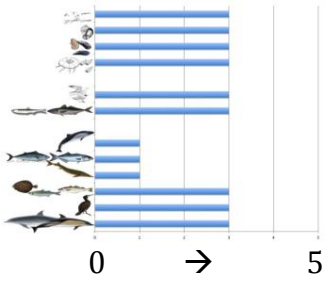
SI Table 2

Cultural Scoping Interview Themes

Theme	Illustrative Thematic Questions
Open Ended	What does the Black Sea mean to you?
Food	Are you aware of any traditional dishes containing animals and/or plants from the Black Sea?
Folklore	Are you aware of any traditional children's stories, folklore, or legends, or jokes and short stories that relate to the Black sea?
Wildlife	Are the animals and plants that live in and around the Black sea important to you?
Community Identity	Are there any community activities that involve the sea?
Society and the Sea	In your opinion, does society benefit from the sea? Questions included on art, religion or spiritual uses (both informal and formal), education, the five senses and recreation
Final questions	Are there any aspects of your culture, linked with the sea, that we have not mentioned? Thank you for your time, is there anything that I missed that you would like to express?

SI Figure 1

This figure shows how each of the levels for each of the attributes were depicted on the choice experiment.

Attribute	Attribute Level Representations		
	BAU	**Moderate New Management**	**Substantial New Management**
Species Visibility 0: No encounter 1: Rare 3: Common 5: Very common			
Local Anchovy in 2020 1: Local quantity 2: Available... 3: Sources 4. Quality	Substantial decrease compared to now Rarely From sources other than the Black Sea Limp texture, Large percentage spoiled	Slight increase compared to now Winter only Some from Black Sea, Some from other sources Moderate texture, Some spoiled	Substantial increase compared to now Winter and Summer Black Sea Only Firm texture, Few spoiled
The excessive increase of jellyfish calendar [Intensity and Duration] No Blooms Low Intensity Moderate Intensity High Intensity			
Species Population size (in Western Shelf Black Sea) 0: Almost extinct 1:1/2 historic size 3: Historic size 5: 20-30% more than the historic size			
Price (TL)	3, 7, 20, 60, 150, 400		

SI Table 3

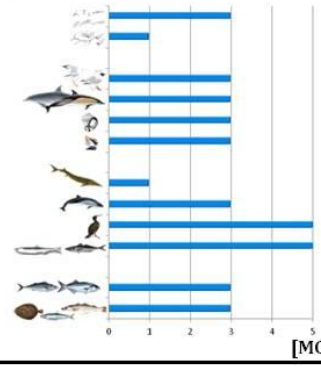
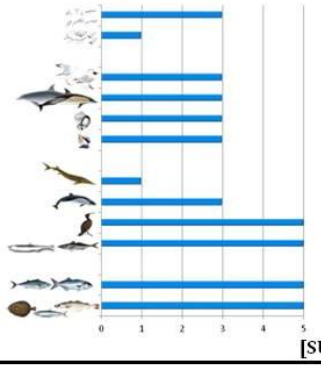
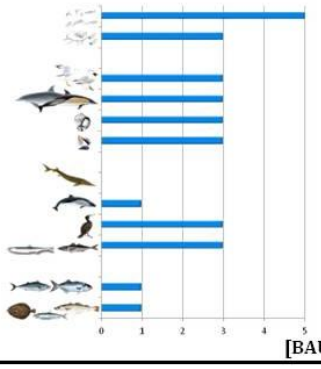
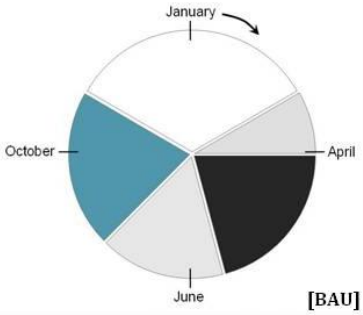
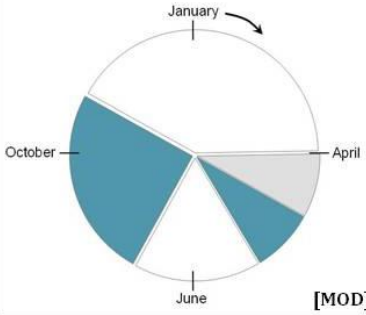
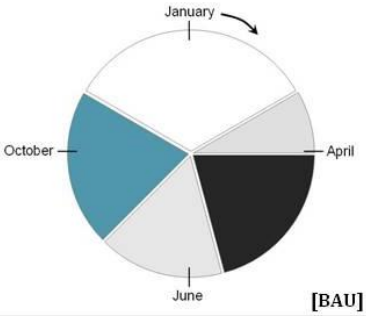
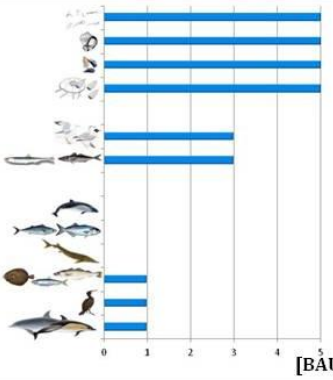
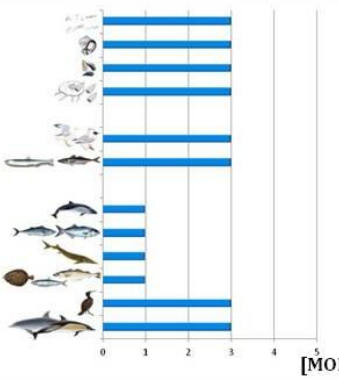
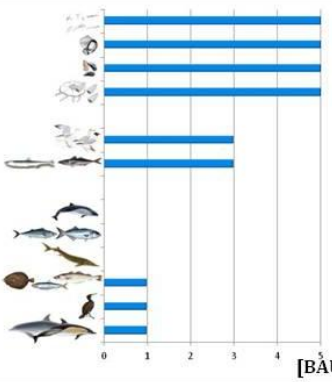
This table shows the changes represented by shifting between the three levels of the population and visibility attribute.

Flagship Species		Population Attribute		Visibility Attribute	
Category	**Name**	**BAU → Moderate**	**Moderate → Substantial**	**BAU → Moderate**	**Moderate → Substantial**
Dolphins	Bottlenose Dolphin Common Dolphin	50% Historic Size → Historic Size	**	**	**
Rarer Marine Mammals	Harbour Porpoise	Almost Extinct → 50% Historic Size	**	Rarely Visible → Commonly Visible	**
Pelagic Fish	Atlantic Bonito Blue Fish	Almost Extinct → 50% Historic Size	**	Rarely Visible → Commonly Visible	Commonly Visible → Extremely Commonly Visible
Oily Fish	Horse Mackerel Anchovy	**	**	Commonly Visible → Extremely Commonly Visible	**
Demersal Fish	Turbot Whiting Grey Mullet	**	50% Historic Size → Historic Size	Rarely Visible → Commonly Visible	Commonly Visible → Extremely Commonly Visible
Rare, Large Fish	Sturgeon	Almost Extinct → 50% Historic Size	**	Never Encountered → Rarely Visible	**
Sea Birds	Cormorant	50% Historic Size → Historic Size	**	Commonly Visible → Extremely Commonly Visible	**
	Common Gull Black Headed Gull	**	**	**	**
Shell Fish	Med. Mussel Veined Rapa Whelk	20-30% > Historic Size → Historic Size	**	**	**
Gelatinous Creatures	Comb Jelly Moon Jelly	20-30% > Historic Size → Historic Size	**	Commonly Visible → Rarely Visible	**
Assorted Plankton		20-30% > Historic Size → Historic Size	**	Extremely Commonly Visible → Commonly Visible	**

'**' indicates no change

SI Figure 2

A sample choice card (English version). The levels of the attributes are shown in brackets for readers of the article but were not shown to respondents on the Turkish version of the choice experiment.

	A	B	BAU
Visibility 0: No encounter 1: Rare 3: Common 5: Very common	 [MOD]	 [SUB]	 [BAU]
Traditional Food 1: Quantity 2: Availability 3: Sources 4: Quality	Substantial Increase Compared to Now Winter and Summer Black Sea Only Firm texture, Few Spoiled [SUB]	Slight Increase Compared to Now Winter only Some from Black Sea Moderate Texture, Some Spoiled [MOD]	Substantial Decrease Compared to Now Rarely None from Black Sea Limp Texture, Large Percentage Spoiled [BAU]
Jellyfish Blooms Intensity None Low Moderate High	 [BAU]	 [MOD]	 [BAU]
Population 0: Almost Extinct 1: 50% Historic Size 3: Historic size 5: 20%-30% More than Historic Size	 [BAU]	 [MOD]	 [BAU]
Price	**20 TL**	**150 TL**	**0 TL**

SI Table 4

Question Themes validating the links between Turkish culture and the health of the Black Sea.

Question	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
It is important to you that the anchovy in the traditional dishes comes form the Black Sea	0.3%	2%	2%	24%	71%
Dishes including anchovy are important to Turkish culture	0.7%	1%	4%	30%	64%
I believe the presence of small-scale, family run fishing businesses is important to our local culture	0.7%	2%	8%	47%	41%
The quality of the biological life in the sea is important to traditional songs, dancing, and poetry linked with the Black Sea	1%	7%	13%	34%	44%
The Temel and Fadime stories make you care about the wildlife of the Black Sea	3%	9%	14%	40%	32%

Number of responses per question=284-289, depending on the individual question; %'s based on full sample of n=291

Table 1
MXL models estimated from the CE data.

Attribute	MXL (Basic) Coefficient		MXL (Basic) Standard Error	MXL (Education * Price) Coefficient		MXL (Education * Price) Standard Error
Mean Estimates						
ASC	- 2.896	***	0.455	- 2.936	***	0.458
Price	- 0.007	***	0.001	- 0.009	***	0.001
Price * Education				0.003		0.001
Visibility (Moderate)	0.294	***	0.080	0.293	***	0.080
Visibility (Substantial)	0.429	***	0.104	0.434	***	0.104
Traditional Food (Moderate)	0.543	***	0.088	0.542	***	0.087
Traditional Food (Substantial)	0. 968	***	0.127	0.971	***	0.126
Bloom (Moderate)	0.479	***	0.090	0.482	***	0.090
Bloom (Substantial)	0. 681	***	0.125	0.679	***	0.125
Population (Moderate)	0.623	***	0.097	0.613	***	0.096
Population (Substantial)	0. 966	***	0.104	0.960	***	0.103
Sigma (σ)	2.634	***	0.350	3.782	***	0.348
Random Parameter Standard Deviations						
Visibility (Moderate)	0.007		1.474	0.009		1.463
Visibility (Substantial)	0.251		0.252	0.236		0.273
Traditional Food (Moderate)	0.482	***	0.145	0.458	***	0.149
Traditional Food (Substantial)	1.003	***	0.132	0.989	***	0.130
Bloom (Moderate)	0.020		1.071	0.018		1.098
Bloom (Substantial)	0.438	*	0.203	0.433	*	0.204
Population (Moderate)	0.804	***	0.134	0.786	***	0.137
Population (Substantial)	0.667	***	0.135	0.670	***	0.135
Adjusted-ρ^2	0.260			0.266		
Final log-likelihood	- 1979			- 1970		

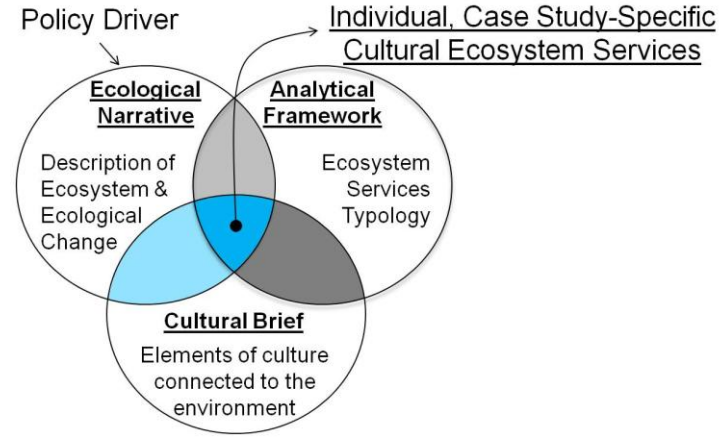
***,* significant at 1%, 5% level, respectively; Estimated using 1,000 Halton draws

Table 2
Mean, annual Willingness-to-pay (WTP) values (2012 Turkish Lira).

	Full Sample WTP			Low Education WTP			High Education WTP		
		95% CI*			95% CI			95% CI	
Attribute	Mean	Lower	Upper	Mean	Lower	Upper	Mean	Lower	Upper
2012 Turkish Lira									
Visibility (Moderate)	41	23	60	33	18	48	50	28	72
Visibility (Substantial)	61	40	82	49	32	67	74	47	100
Traditional Food (Moderate)	76	59	94	62	48	77	92	70	113
Traditional Food (Substantial)	135	110	160	110	89	130	166	133	201
Bloom (Moderate)	67	48	86	54	39	70	82	58	105
Bloom (Substantial)	94	70	117	77	57	97	116	87	145
Population (Moderate)	86	65	107	70	52	87	105	78	132
Population (Substantial)	135	113	157	109	92	127	164	134	196

*95% confidence intervals (CI) calculated using Krinsky-Robb method with 2,000 draws; Values rounded to nearest whole Turkish Lira

Graphical Abstract



Augmented ES Valuation Framework

figure 1_color.jpg

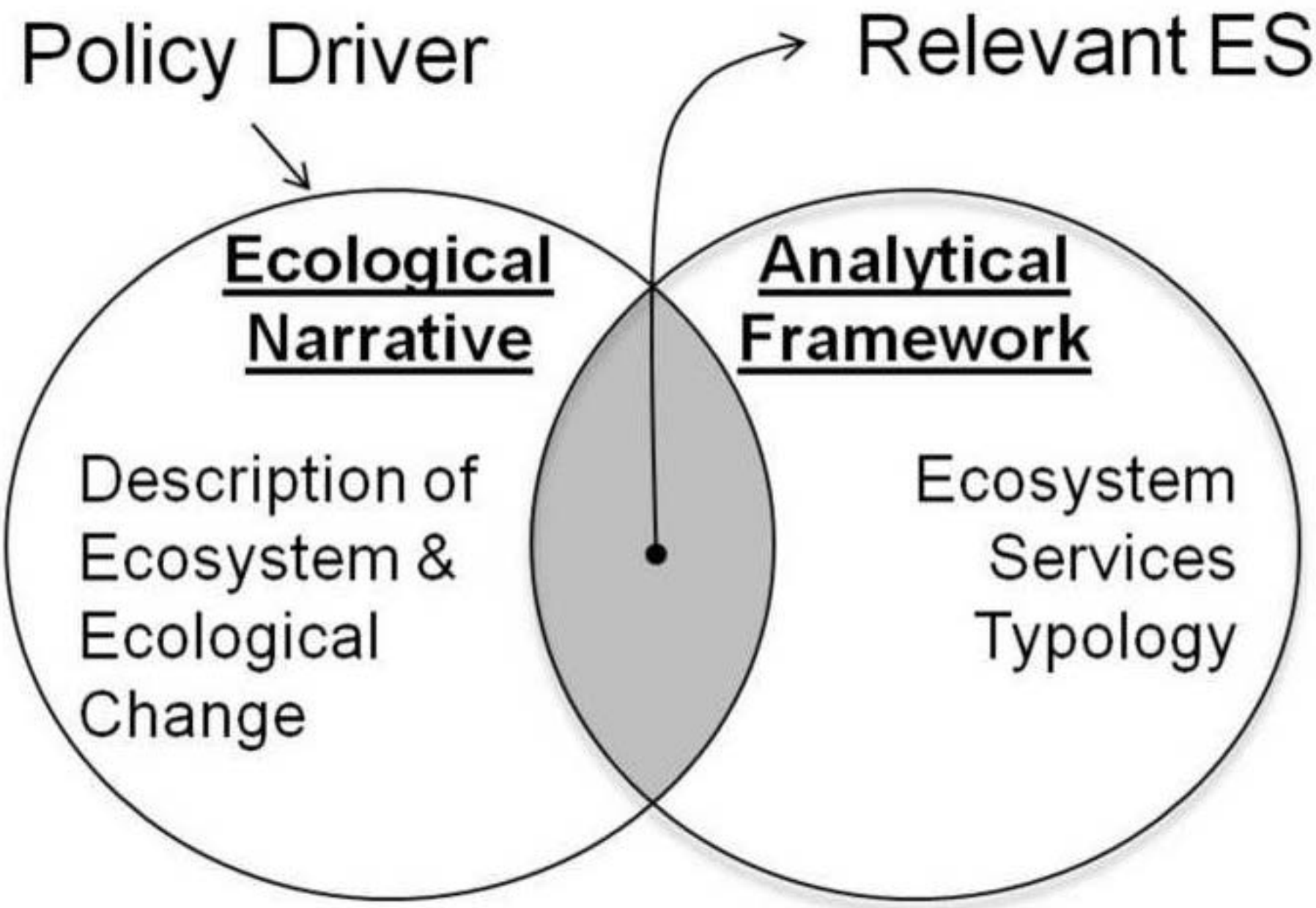
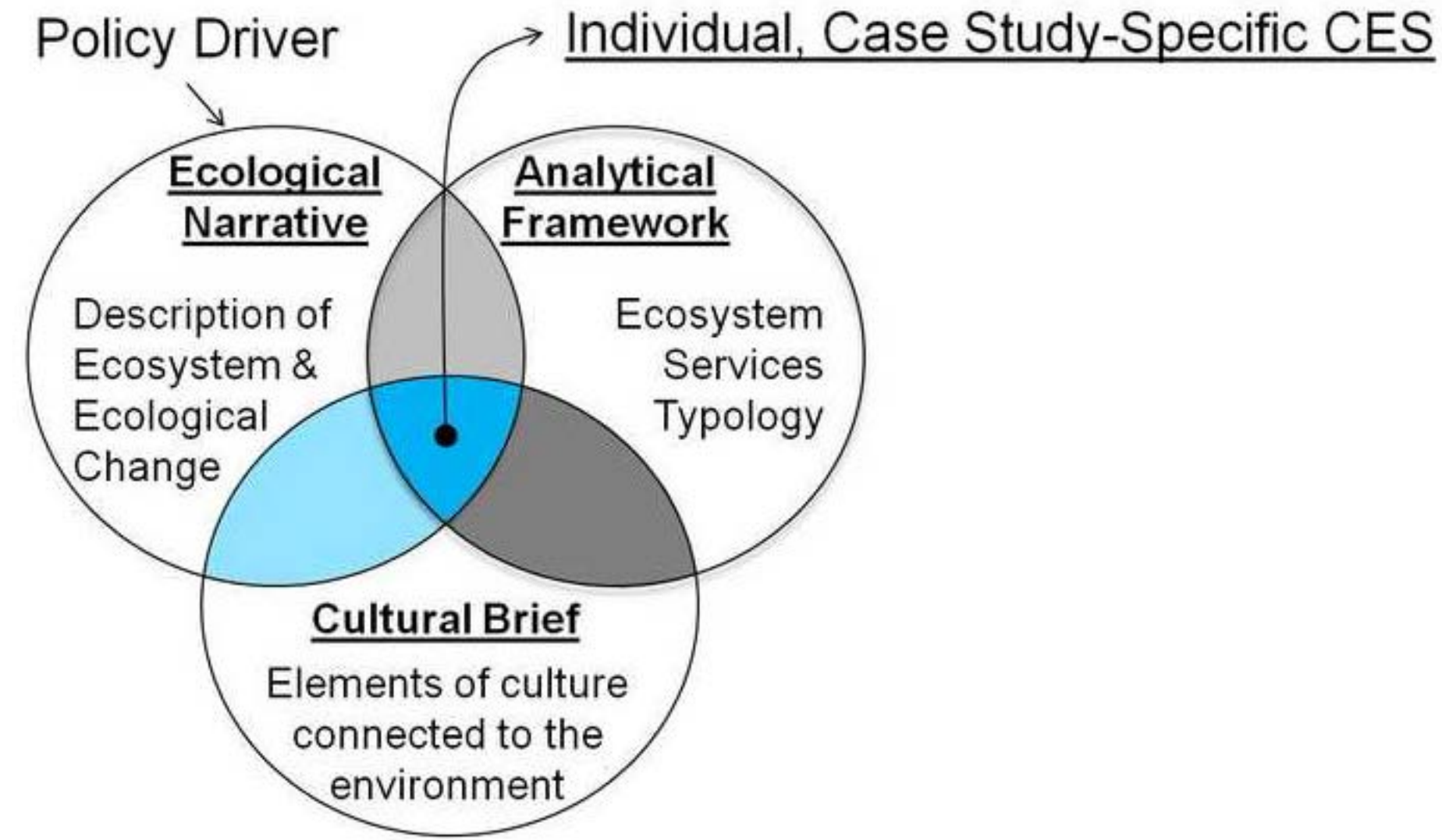


Figure 2



Augmented ES Valuation Framework

figure 3_color.jpg

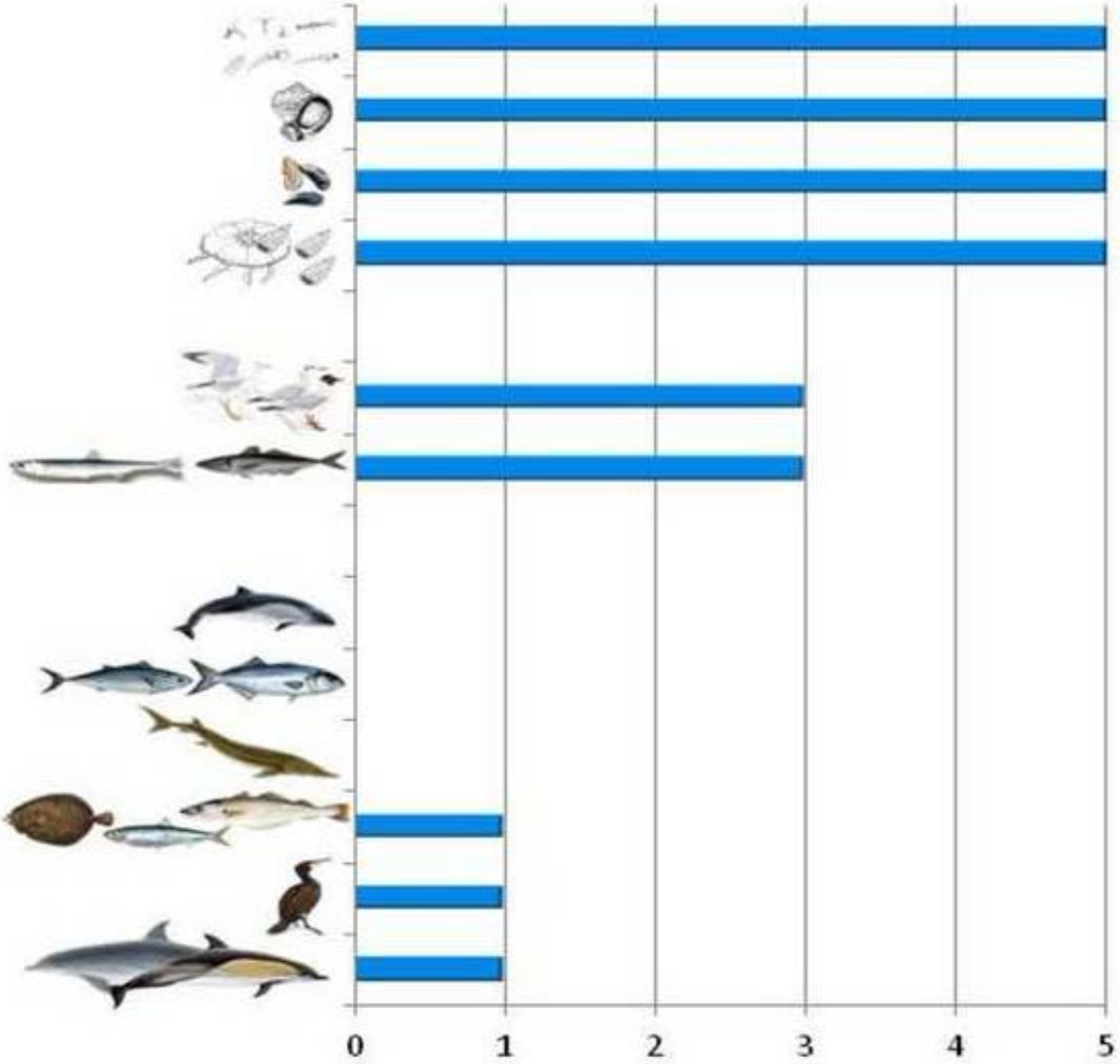


figure 4_color.jpg